types, principally from culture animals, have been added, including *Amœba lacertæ, A. diploidea, Entamœba muris, E. tetragena, Trichomonas muris, Lamblia* (and *Octomitus*) *muris, Leucocytozoon ziemanni, Proteosoma præcox* and *Balantidium coli.*

The plan of treatment is comprehensive, including general introductions to each group, and detailed accounts of the morphology and life history of each of the forms discussed together with directions for securing, controlling, cultivating and preparing the material for study. Illustrations often in color, illustrate the various stages and assist materially in the interpretation of laboratory material. Brief bibliographies of a few pertinent papers are appended.

It is to be regretted that the student of *Babesia canis* is left uninformed of Nuttall's work, that Fantham's work as well as Schellack's on spirochætes is not cited and that the sexual phase of the cycle of *Trypanosoma lewisi* is described as reported by Prowazek in *Hæmatopinus* without any hint as to the reserve with which his conclusions on this point have been generally received. This lack of caution is all the more regrettable in the light of Minchins's experiments with fleas as carriers and Doflein's recently published results of his experimental cultures and his conclusions as to the necessity of caution in interpreting stout and slender forms as sexual gametes and their conjunction as conjugation.

No chapter on technique of parasite flagellates is complete either historically or technically without calling the student's attention to the culture methods of Novy and MacNeal. Such omissions as these are hardly to be condoned by the fact that the author is writing primarily for the German student.

The figures are often original and are uniformly excellent. The condensed but comprehensive and lucid account of the significant features of the structure and life history of the important pathogenic and parasitic types available for laboratory use will be of greatest assistance to the student in this difficult field.

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TRIPHENYLMETHYL

Since modern methods of formulation were established, organic chemists have been able to represent the many thousands of compounds, whose constitution has been elucidated, by formulas in which the carbon atoms are always tetravalent. The single exception was carbon monoxide, CO, in which the carbon is necessarily represented as being bivalent.

In view of these facts it was natural that Gomberg's discovery of "triphenylmethyl," $(C_6H_5)_3\overset{*}{C}$, should arouse widespread interest, because, if it be correctly formulated, the carbon atom marked * is trivalent. During the ten years which have elapsed since Gomberg's discovery was first announced, a very large amount of work has been carried out in order to elucidate the true nature of triphenylmethyl. The most important contributions, which are summarized below, have been made by Gomberg himself, by A. E. Tschitschibabin, A. von Baeyer and more recently by W. Schlenk[1] and his co-workers in Baeyer's laboratory.

"Triphenylmethyl" is prepared by the action of certain metals, such as zinc, on triphenylchloromethane, $(C_6H_5)_3CCl$; the metal simply removes the chlorine atom. "Triphenylmethyl" exists in two forms, a white, solid modification, which is relatively stable, and a soluble yellow form exhibiting very great chemical activity. This colored variety has a molecular weight corresponding to the simpler formula, $(C_6H_5)_3C$.

As regards the colorless material, the facts pointed to its being hexaphenylethane, $(C_6H_5)_3C\cdot C(C_6H_5)_3$, but many chemists hesitated to accept this view, chiefly, perhaps, for the following reasons. The substitution of phenyl groups for hydrogen in hydrocarbons results, in general, in an increase in the stability of the product, consequently, in passing from ethane, $CH_3\cdot CH_3$, to hexaphenylethane, $(C_6H_5)_3C\cdot C(C_6H_5)_3$, we should expect to obtain an inert substance, but we find that the "hexaphenylethane," mentioned above, is so unstable that its mere solution, at the ordi-

[1] *Ber. d. chem. Ges.*, **43**, 1753, 3541, 1910.

nary temperature, causes its decomposition into "triphenylmethyl," $(C_6H_5)_3C$.

An investigation of the ethanes containing a smaller number of phenyl groups, from one up to five, would obviously be calculated to throw light on these points. This work has been carried out and it has been found that a very stable compound, which was formerly regarded as being hexaphenylethane, actually possesses a different constitution. It has also been shown that, in certain respects, there is a decrease in stability and an increase in chemical reactivity as the number of phenyl groups in the ethane molecule becomes greater. Thus, for example, pentaphenylethane, $(C_6H_5)_3C \cdot CH(C_6H_5)_2$ is decidedly less stable than tetraphenylethane, $(C_6H_5)_2CH \cdot CH(C_6H_5)_2$.

The final link in the chain of proof has been furnished by Schlenk, who has just shown that if the pentaphenylethane be heated with a neutral solvent of high boiling point, it is decomposed into triphenylmethyl and tetraphenylethane, in the manner indicated by the dotted line in the formula,

$$(C_6H_5)_3C \quad CH(C_6H_5)_2;$$

the tetraphenylethane results, of course, from the combination of two of the groups, $CH(C_6H_5)_2$. It follows, therefore, that there is no difference, in principle, between the behavior of pentaphenylethane and hexaphenylethane towards solvents; when in solution, both give triphenylmethyl, the latter at the ordinary temperature, the former only when it is heated.

In view of these results there is no ground for doubting that the colorless solid obtained by Gomberg is really hexaphenylethane, $(C_6H_5)_3C \cdot C(C_6H_5)_3$, and that its passage into solution, at the ordinary temperature, suffices to resolve it into two molecules of colored triphenylmethyl, $(C_6H_5)_3C$.

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SPECIAL ARTICLES

SUGGESTIONS AS TO THE CULTURE OF BUTTERFLIES

BUTTERFLIES, with their clear-cut color patterns and brilliant hues, their remarkable polymorphism seen in the occurrence within a single species of two or more seasonal forms, or of melanic, albinic or other varieties often limited to individuals of one sex, furnish a most inviting field for the student of evolution and heredity. The fact that in America, at least, no precise and long-continued work on heredity in diurnal lepidoptera has been undertaken hitherto is probably due in part to the belief that the mating of butterflies, occurring usually in the air, would be difficult to bring about in small cages; though the mating of moths under such conditions is generally known to be an easy matter. It is my purpose in this article to correct this false impression in regard to the mating of butterflies, and to make other suggestions as to methods of caring for this dainty live stock, of marking individuals to indicate their pedigree, and of preserving them in a more compact, permanent, convenient fashion than the usual impalement on long pins in bulky drawers or boxes.

One who undertakes the study of the heredity of butterflies may of course begin either with live wild females, presumably already impregnated, or with eggs already laid, with larvæ, or with chrysalids. For transportation over long distances chrysalids, or eggs upon the food plant, are usually to be prefered. Living plants with roots intact and leaves covered with eggs may be shipped in tin boxes by mail. But often only the imago can be obtained. In this case, and always, if the distance is not too great, sending live butterflies by mail in strong, cylindrical tin boxes lined with moist blotting paper that is held firmly in position is to be recommended. I have found that *Colias philodice*, shipped 150 miles in this way, and shut up closely for eighteen hours, stands the journey well, and lays abundantly, if well fed with sweetened water upon arrival.

For purposes of identification it is of course necessary for the student of heredity to label each living adult butterfly. This is readily done by writing the sign of the family and individual with pen and ink upon the under